What Drives Performance of Indian IT Firms in Clusters?[1]

Rajesh S. Upadhyayula[2] Prof. Rakesh Basan[3]t and Prof. Pankaj Chandra[4]

Introduction

Of late, the economic development of India has been driven by Information Technology industry. Consecutive Governments (both at the Center and the States) have given a lot of impetus through a variety of incentives / subsidies in promoting India's advantage in Information Technology industry. Globally, India is currently considered as a leader in information technology industry. It has been one of the fastest growing industries in India. The contribution of this industry to the national economic output tripled from 1.2 percent in the year 1997-1998 to 3.5 percent in 2003-2004(GOI, 2005). The number of IT and ITES professionals employed have grown from 284,000 in 1999-2000 to over a million in 2004-2005(GOI, 2005). The absolute contribution of IT industry in India (including hardware) is estimated to be USD 36.3 billion in 2006 up from USD 21.6 billion in 2004(NASSCOM, 2006). It was also estimated that the contribution of IT and ITES services in India through exports is USD 19.5 billion in 2006 from USD 10.4 billion in 2004. Further, NASSCOM also suggests that India is a destination for other services such as engineering services, R&D and testing of software products. While the above case is partially true, the contribution of Indian economy to outsourcing industry is quite small compared to global outsourcing figures. According to International Data Corporation, the global demand for IT services was estimated to be USD 416 billion in 2004 and is expected to grow to USD 555 billion in 2009. Of the above, the IT services outsourcing opportunity is expected to grow from USD 148 billion in 2004 to USD 218 billion in 2009. India does not even contribute to 10% of total outsourced opportunity. Further, of the current off-shored IT services market, Indian firms hold 75% market share. Thus, there is a limitless opportunity for Indian firms in the outsourced market. This exponential growth of the IT industry has attracted a lot of media and academic research attention over the last decade (Basant, 2005).

Some of the earlier explanations of the growth of the Indian IT services industry is due to its absolute cost advantage in the sector(Heeks, 1996), whereas the recent explanations include factors like comparative cost advantage, increasing productivity, etc (Arora, Arunachalam, Asundi, & Fernandes, 2001; Athreye, 2002, 2003, 2004b). Recently, authors have argued that the changing nature of capabilities of Indian IT firms as an important determinant of its performance (Balasubramanyam & Balasubramanyam,

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[1] This paper draws heavily from the doctoral dissertation of the author. The author would like to thank his mentor / guides as well as the examination committee for their critical comments and support.

[2] Manager, Corporate Think Tank, Tata Consultancy Services,
17, Cathedral Road, Chennai Phone: +91-44-66164473
(rajesh.u@tcs.com)

[3] rakesh@iimahd.ernet.in

[4] pankaj@iimahd.ernet.in

2000; Caniels & Romijn, 2003). Some of these significant changes in capabilities include onsite to off-shore/onsite to off-shoring model, improvements in quality certifications, experiments in domain knowledge & specializations, changes in the portfolio of geography, infancy of product capabilities, and mergers & acquisitions (for leveraging capabilities of firms outside)(Upadhyayula & Karthik, 2006). Additionally, Athreye has suggested that this growth of Indian IT industry can be attributed to the role played by Bangalore-Chennai-Hyderabad, Noida-Gurgaon-Delhi, Mumbai-Pune regions (Athreye, 2002). However, most of studies missed the opportunity to explain the performance of Indian IT firms due to reasons relating to clustering. It is well known that clusters/regions played an important role in growth of certain key industries in other countries/regions too, for example, Silicon Valley in USA, Prato in Italy, and Detroit in USA. While most explanations before 1990 focused on cost and/or resource based advantages for firms in clusters, recent explanations highlight the role of learning/knowledge spillovers leading to capability formation in firms (Basant, 2002). In this paper, we show that that Indian IT firms' capabilities and resource based advantages (due to their presence in a cluster) helps them perform better than IT firms located outside clusters. Additionally, we also show that scale economies as the only significant factor affecting the performance of IT firms outside clusters. The rest of the paper illustrates the generic framework including hypotheses, methodology adopted for testing the hypotheses and some of the results highlighting the importance of various capabilities and resources for performance of Indian IT firms in clusters.

Section 1 illustrates a comprehensive generic framework i.e., factors affecting or contributing to the performance of firms within and outside clusters. Section 2 traces the evolution of Indian software industry and how clusters contributed to the performance of Indian IT industry. This is followed in section 3 by a brief discussion on the methodology as well as a brief description of the sample firms. In section 4, we highlight the important factors contributing to the performance of Indian IT firms in and outside clusters. The last two sections summarizes our findings and identifies some of the policy and managerial imperatives.

Factors affecting performance of firms in clusters

Clustering as a phenomenon existed for several years. Alfred Marshall (1890) listed three fundamental advantages for firms to locate in clusters. These include availability of raw materials and other intermediate inputs, local market for specialized skills and a source of new ideas to firms. Till the last decade of the 20th century, the explanations for clustering focused on cost / resource based advantages (Ernst, Guerrieri, Iammarino, & Pietrobelli, 2001; Krumme, 1969) and largely ignored the importance of knowledge / learning / innovation as a reason for clustering of firms (Porter, 1998a). While cost / resource based advantages could explain the presence of clusters to a large extent, it was felt that this should diminish owing to a reduction in transportation and communication costs (Porter, 1990). However clusters continued to dominate the economic landscape of nations / regions (Porter, 1998a). Thus, economists and policy makers tried to seek other possible reasons for existence of clusters.

Recent studies suggest that largely clusters possess specialized skills, knowledge and specialized institutions. Infact, it was argued that academic institutions played a key role in the early advancement of Bangalore cluster (Basant, 2005). Porter (1998a) suggests that competition between firms as one of the possible reasons by which firms were able to foster greater innovation in clusters and thus better performance than firms outside clusters. Even Marshall (1890 p. 223), observes that “When an industry has chosen a locality for itself, it is likely to stay there long; so great are the advantages which people following the same skilled trade get from near neighbourhood to another. The mysteries of the trade become no mysteries; but are as it were in the air……if one man starts a new idea, it is taken up by others and combined with suggestions of their own; and thus becomes the source of further ideas.” Thus the recent approaches to the analysis of clustering shifted from static economic factors to mechanisms of knowledge diffusion and accumulation by firms in clusters, where learning and knowledge exchanges are embedded in a distinct environment(Guerrieri, Iammarino, & Pietrobelli, 2001). Some of the reasons provided for greater knowledge flows / spillovers to clusters include knowledge characteristics (such as tacitness, complexity and context specificity) (Basant, 2002; Feldman, 1999; Kogut & Zander, 1992; Lundvall & Johnson, 2001), local networks, national and international networks (Ernst, 2002; Knorringa, 1999; Maskell & Malmberg, 1999; Porter, 1998b; Saxenian, 1990; Hubert Schmitz & Nadvi, 1999), government intervention(Cooke, Uranga, & Etxebarria, 1997; Feldman, 2001; Kennedy, 1999) and policy regime(Basant, 1997; Lall, 1987; Morris, Basant, Das, Ramachandran, & A., 1999). Although, there were a number of case studies which highlight this point, the current paper would not discuss the determinants of knowledge flows / knowledge spillovers / capabilities of firms in clusters in comparison to firms outside cluster.[5] Thus, this paper hypothesizes the relationship between knowledge spillovers / knowledge flows as well as resources (accessibility to raw material, skilled labour, availability of infrastructure and other key inputs) and performance of IT firms within clusters and outside clusters. However, the relationship between cost based factors and performance was not captured as part of this study.

Although, knowledge spillovers / knowledge flows were measured using various proxies such as patents (Feldman, 1999), labour mobility (Almeida & Kogut, 1997), R&D expenditure and paper citations (Jaffe, Trajtenberg, & Henderson, 1993), most of them do not capture the incremental nature of knowledge flows or capability building. Since patent / paper citations are quite low in developing countries, this would not be an appropriate measure for capturing knowledge flows to firms in clusters or outside clusters. It was suggested that knowledge flows / knowledge spillovers can lead to capability formation / production improvements in firms (Ernst & Kim, 2002; Kogut & Zander, 1992; Mytelka, 2004; Hubert Schmitz & Nadvi, 1999). For the purposes of this study, we assume that knowledge flows / knowledge spillovers lead to capability formation and hypothesize the relationship between capabilities of IT firms and performance.

Studies define capabilities in a variety of ways. Chandra (1995) categorized technology as knowledge embodied in three Ps.: products, processes and practices. Building on this conceptualization, Basant (2002) contended that the three P framework can be extended to characterize knowledge of a firm. Chandra (1995 p. 3) specifies the three Ps as follows:

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[5] For a detailed analysis of determinants of capabilities you may refer to the author’s doctoral dissertation at IIM, Ahmedabad

- Technology embodied in products: They comprise the knowledge of how things work, their design, and their interface with other products. Thus, knowledge embedded in a firm's product/output would be covered here.
- Technology embodied in processes: They comprise knowledge on the laws of transformation, on how a product can be produced or changed, and on the relationship between different components that comprise the process. Thus, knowledge embedded in firms processes include the understanding of the physical laws of transformation, raw material and machinery used for producing the output.
- Technology embodied in practices: They consist of the grammar or the language necessary to manage the product-process combine and the knowledge re-generation process. Thus, practices would include among other things, the organizational laws/routines, which enable the efficient and effective transformation of inputs into outputs.

Chandra's (1995) conceptualization of technological capability would therefore be in terms of knowledge embodied in 3Ps at the firm level. Bell and Albu (1999 p. 1723) also indicate that knowledge flows helps in generating or changing technological capabilities in three domains: products, processes and production organization. Lipsey (2002) also has a conceptualization similar to that of Chandra (1995). The difference is that instead of practices, he used the term organizational routines (which probably do not encompass the practices related to generation of new knowledge) (Basant & Chandra, 2002).

Overall, one can see a significant amount of overlap in the conceptualizations of Chandra (1995), Bell and Albu (1999) and Lipsey (2002). Chandra's (1995) 3P framework of capabilities seems to cover the essential elements of all three categorizations apart from having the advantage of easier operationalizability at the firm level. This is due to the easy observability of products, processes and practices in a firm. The proposed study would therefore broadly follow this conceptualization for measuring capabilities and knowledge embedded in these capabilities of IT firms. The third section describes the operationalization of these capabilities for IT firms.

Apart from capabilities, studies also suggest that significant differences exist between cluster and non-cluster locations in terms of resource based advantages derived by firms in clusters. Some of the advantages that firms in clusters derive include proximity to customers, availability of skilled labour, presence of suppliers, access to support services, access to training facilities and R&D institutions, availability of maintenance/repair services, better access to information from / about competitors, availability of information on marketing fairs and exhibitions(Krumme, 1969). Studies also suggest that there can be significant differences in the type of infrastructure available between cluster and non-cluster locations. This could also lead to differences in performance of firms within and outside clusters (Athreye, 2004a; Cooke et al., 1997; Dahl & Pedersen, 2004). We also contend that requirements of government support may also be significantly different for firms within and outside clusters. This also reflects the basic locational differences between cluster and non-cluster locations. For example, constraints in subsidies, arranging fairs and exhibitions and providing marketing support may be detrimental for performance of firms outside clusters, whereas firms within clusters may have this information in cluster due to the presence of other service providers. Thus, absence of government support may impinge the performance of firms outside clusters than firms within clusters. Thus, structural differences across clusters and non-cluster locations contribute to differentials performance of firms within and outside clusters.

We suggest that capabilities contribute to performance of both firms in and outside clusters. In addition, we hypothesize that performance differentials exist between firms in and outside clusters due to locational differences (i.e., presence of a firm in and outside clusters). These locational differences can be in terms of significant differences in availability and access to raw materials, intermediate inputs/services, skilled labour, consultancy & support services, physical infrastructure and government policy support. Thus, we hypothesize the following:

> *Proposition: Higher capabilities of a firm are associated with higher performance of firms.*
>
> *Proposition: Firms in clusters perform better in comparison to firms outside clusters.*

Indian Software Industry

The roots of the current industry can only be traced back to 1980. Before that, the industry principally grew due to the domestic market. The export led growth was principally due to the advent of networked computing in 1980s. This led to a number of Indian firms doing on-site projects[6] for firms abroad using the human capital from India (Heeks, 1996). The on-site projects further fueled the growth of the software industry in early 1990s. Later part of 1990s saw a further change in the structure of software industry which started employing a combination of off-shore/on-site model (Athreye, 2003). Even after a decline in Y2K business, the software industry in the period 1999-2000 continued to grow at over 50% (Exhibit 1).

As discussed briefly earlier, the seeds of this high growth can be traced back to 1970s. The period 1970-1980 was marked by the exit of IBM due to Foreign Exchange and Regulation Act (1973) in 1978. This led to the establishment of Computer Maintenance Corporation (a public sector undertaking) for maintenance of IBM mainframe computers. A number of employees of IBM started their own enterprises during this period in Bangalore. Unlike other industries including electronics, this industry was not restricted through Monopolies and Restrictive Trade Practices Act (1969). This meant that entry was free even for large industrial houses and software services were developed by both large domestic private players and public sector undertakings. Thus, large industrial houses and public sector undertaking played a crucial role during the period 1970-1980 in the development of software industry (Athreye, 2002). An interesting aspect of the software policy during this period was that firms were allowed to import hardware only if they could export software. This coupled with no controls on the entry of large houses led to the growth of the software services sector (Heeks, 1996). The growth of the industry

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[6] ***Onsite:*** Software development, which is carried out by a third party at the client's location is referred to as on-site work.
Offshore: Offshore is any location, which is located outside the home country of the client. In the context of software, if a US based organization outsources its software development work to a company based in India, it would be referred to as off-shoring.

was also further aided by a growing world market for software, low investment requirements for establishing new ventures, availability of skilled English speaking population and low wage rates.

Further, the period from 1980-1990 was marked by a decrease in delicensing of hardware and the first steps to promote science technology parks in India and export processing zones. While the infrastructure advantages could never be realized, the domestic firms were allowed to establish their own dedicated satellite links and invest in power generation (Athreye, 2002). Since the costs were very high in developing one's own infrastructure, the focus was to ship people abroad for providing software services (on-site model). The excessive thrust on exports led to a neglect of the domestic industry with no significant signs of its growth even now (Exhibit 1). From Exhibit 1, we can see that there has been a ten fold increase in domestic revenues from 1994-1995 to 2003-2004 whereas software exports had a 30 fold increase. Thus, studies emphasized that the export orientation of this sector is considerably higher compared to other sectors in India even during the early phases of its development (Joseph, 2004). The same did not happen in other sectors because the government policies in other industries were mostly import substitution oriented and this led to a reduced competition in the Indian domestic market, thus holding back exports. Similarly government also provided a host of other incentives like Power, etc to promote software development in the State). Special economic zones (SEZs) and Software Technology Parks of India (STPI) was also instrumental for promotion of this industry.

Liberalization in 1990 coupled with relaxations in norms of foreign investments led to the development of off-shore model. The period (1990-2000) was marked by an increase in the entry of multinational firms (Athreye, 2002). The entry of MNCs was because most of these MNCs realized that they derive significant cost advantages if they establish development centers in India. This led to increased competition in the factor market i.e., labour. Further, this may have fuelled the growth of off-shore development model. The off-shore component which was less than 5% before 1990 increased to 35% by 1999-2000 (Athreye, 2002). The increased competition in the software factor market led domestic firms rethink their strategies. Most domestic IT firms have invested significantly in quality certifications, specialized in particular domains and were trying to move up the value chains during the later part of the last decade.

While previous studies argued cost arbitrage as the most important factor, recent studies emphasize that Indian firms have been consistently moving up the value chain moving from the provision of simple service tasks to offering wholly integrated packages (Arora et al., 2001). More recent arguments cited comparative cost advantage (measured in terms of returns) of the software firms compared to other domestic firms (Arora and Athreye, 2002) as a more important reason for growth of the software sector. Besides, it was also found that the productivity of software industry is twice that of other industry, whereas in USA it is just 1.3 times other industries (Arora and Athreye, 2002). Athreye (2003) also suggested that the growth of the software industry is due to it ability to develop and adapt various capabilities (process level capabilities and domain level competencies) to deliver the software service more effectively and efficiently. From Exhibit 2, we can see that there is an increasing proportion of high-end services like IT consulting and package implementation. Thus, Indian IT firms are developing capabilities to deliver high-end software services too. We operationalize capabilities of IT firms in the next section. Further, Exhibit 3 shows the distribution of state wise exports of software services. This shows that software exports are concentrated in Karnataka, Maharashtra, Tamil Nadu, Andhra Pradesh, Uttar Pradesh and Delhi. This shows that IT firms are agglomerated across a few regions. Apart from the government policies which led to this tremendous growth, availability of labour or access to skilled labour also affects regional dispersion of IT industry. From Exhibit 4, we can see that the intake of graduates in information technology and computer science courses is higher in Karnataka, Maharastra, Andhra Pradesh, Tamil Nadu, Haryana and Uttar Pradesh. Thus, one of the reasons for clustering of firms in Bangalore, Pune, Hyderabad, Chennai, Mumbai and NCR may be due to availability of skilled labour. Thus, mostly the reasons for the high growth of the software industry in India include cost advantages (labour arbitrage), availability of skilled labour, government policies (supporting the growth intentionally or unintentionally) and improvement in capabilities of IT firms.

Despite this stupendous growth, Indian IT industry is agglomerated in a few core regions. Athreye (2003) finds that Information Technology (IT) firms spatially agglomerate in Bangalore-Hyderabad-Chennai, Mumbai/Pune and National Capital Region (NCR). A city wise analysis of membership profile of National Association of Software and Service Companies (NASSCOM) given in Exhibit 5 confirms that Bangalore, NCR, Mumbai, Chennai, Pune and Hyderabad as concentrations of IT firms. An analysis of the exports through Software Technology Parks of India (STPI) also shows that Bangalore, Noida, Pune, Chennai, Hyderabad and Navi Mumbai are regions of IT firm concentration (Exhibit 6). Thus, location played a role in the development of software industry in India too. Additionally, we can also argue that knowledge flows / spillovers to software firms as well as resource availability in these regions (due to government policies or otherwise) contributed to the performance. The next section would briefly describe the design and methodology adopted for the purposes of this study.

Research Design

The objective of this paper is to identify the determinants of performance of firms in and outside clusters. We collected primary data by administering questionnaires to senior managers of firms in cluster and non-cluster locations[7]. We have already shown earlier that Bangalore, NCR, Mumbai, Chennai, Pune and Hyderabad as concentration of IT firms. For the purposes of this study, we collected data of IT firms located in Bangalore, Pune and NCR. Since this study is to compare determinants of performance for IT firms in and outside clusters, we also collected data from multiple non-cluster locations too i.e., Chandigarh, Bhubaneswar and Jaipur. In most cases, apart from NCR (where Noida, Gurgaon and Ghaziabad were included), data was collected from firms located only in the cities and their nearby neighbouring areas (i.e., industrial areas of these cities). We collected data from a sufficiently large number of firms (243 in number). Exhibit 7 provides the distribution of firm responses across cluster and non-cluster locations. From Exhibit 7, we can observe that the actual and predicted distributions of IT firms are similar. Thus, we can conclude that our sample is representative of industry profile. However, one of the limitations of this stratification is that it did not capture the

[7] The survey instrument is enclosed as an appendix with the doctoral dissertation of the author "Determinants of knowledge flows to firms in and outside clusters", 2006

differences in firm size across cluster and non-cluster locations separately. We expect that a larger share of firms outside clusters would have been smaller in terms of sales. Despite a higher presence of smaller firms in non-cluster locations, we explore the relationships between capabilities, locational characteristics and performance. However, we test for homogeneity of the samples while estimating these relationships. The next paragraph discusses issues relating to measurement and operationalization of capabilities, performance and locational characteristics of firms.

Measurement of capabilities: Our study is the first of its kind to operationalize capability at the firm level. Besides, we also discuss issues relating to measurement of advantages of locating in a cluster, infrastructural facilities and government policy support for firms in and outside clusters, which represent some of the locational characteristics (i.e., cluster and non-cluster locations). As discussed earlier, we have categorized capabilities into product, process and practice capabilities. Our study is the first of its kind to operationalize capabilities at the firm level. Tsai (2004) emphasized that capabilities and knowledge till date have been operationalized very rarely in literature.

1. *Product capabilities*: Product capabilities comprise knowledge embedded in a firm's product or output. Most IT firms in India offer a broad range of services rather than off the shelf or shrink-wrapped products. Surveys conducted by Dataquest and NASSCOM categorized services offered by IT firms. These surveys divide software services into IT consulting, package implementation, application development, application outsourcing and application maintenance categories. Studies highlight that some of the software services are high-end services (for example IT consulting and package implementation), while others like application development and maintenance are low-end services. Besides, recent studies have also highlighted that Indian IT firms are also specializing in particular domains i.e., Infosys in Banking, Wipro in manufacturing and Cognizant in Healthcare services (Athreye, 2002). Interviews with senior managers from across a number of IT firms helped us in refining our understanding of product capabilities. Our interviews suggested that a combination of these i.e., software service capability and domain capability put together would form the complete product offering of IT firms. Although, we were able to capture the product (service & domain) capabilities of IT firms separately, we could not measure the combinatorial product capability of IT firms. To get a measure of product capabilities, we interviewed experts (senior management including CEOs) of IT firms to weigh various categories of software services and domains. Despite our efforts to get weights for product categories (software services and domains), there was a lack of consistency across experts on the weights related to these software services and domains. Thus, we could not measure product level capability of IT firms. Despite the above, a recent study had managed to classify software services into few classes (high, medium and low) and shows that Indian IT firms are moving up the value chain too(Joseph & Abraham, 2005). This study classified Y2K solutions, software maintenance and euro currency solutions as low-end software services, whereas business process consulting, ERP solutions, software development, system integration is termed as medium-end and software product development, facility management (outsourcing), chip design as high-end software services. Further, it was also highlighted that the process capabilities (more than product capabilities) determine the amount of value derived by IT firms (Joseph & Abraham, 2005; Schware, 1987).

2. *Process Capabilities*: As discussed earlier, Chandra (1995) defined process capabilities as laws of transformation i.e., on how a product can be produced or changed. We identify various components of software development cycle as process capabilities for IT firms providing application development. Studies indicate that firms adopting requirement analysis, system requirement specification, functional requirement specification, high-end design and low-end design derive 60-65% of total value derived from software development (Joseph & Abraham, 2005; Schware, 1987). The other part of software development process i.e., coding, testing, installation and support do not add value similar to design level processes. Further, interviews with senior mangers also helped us distinguish between processes adopted by firms providing application development and those providing package implementation services (i.e., solution definition, solution engineering, solution production, solution installation and solution support). We could not identify any specific process for IT consulting, application outsourcing and application maintenance services during our interviews. Exhibit 8 shows the application development processes and package implementation processes. We ask firms to indicate whether they adopt / do not adopt each of these processes. Our index of process capability is the number of application development processes and package implementation processes adopted by IT firms i.e., a count of number of "Y"s from exhibit 8. However, we show later, since all firms do not adopt package implementation processes, our measure of process capability is the number of application development processes adopted by IT firms. We ignored the package implementation process capability for the purposes of this study. Thus, our index of process capability can be represented as:

   $$\text{Process Capability Index}^{8} = \sum_{i=1}^{10} X_i \quad \text{where } X_i = \begin{cases} 1 \ \textit{if firm adopts process } i \\ 0 \ \textit{otherwise} \end{cases}$$

3. *Practice Capabilities*: As discussed earlier, practice capabilities include organizational laws or routines, which enable efficient and effective transformation of inputs into outputs (Chandra, 1995). A review of CMM level documents helped us in identifying some of the key coding related practices of IT firms. In-depth interviews with senior managers of IT firms helped us in identifying other key practices like security related practices, knowledge management related practices and training related practices. A detailed listing of practices for IT firms is given in exhibit 9. The practice capability index is computed as follows for IT firms.

   $$\text{Practice Capability Index} = \sum_{i=1}^{19} X_i \quad \text{where } X_i = \begin{cases} 1 \ \textit{if firm adopts practice } i \\ 0 \ \textit{otherwise} \end{cases}$$

While this is one of the first few studies to measure capabilities at the firm level, it is not bereft of limitations. Despite the above, we could not measure process and practice capabilities completely. Our measure also could not capture the extent to which IT and electronic firms adopt various processes and practices i.e., differences in adoption of these processes and practices in each firm. To that extent, our results measure only adoption rather than the extent of adoption. Additionally, we could not measure the product capabilities too. Thus, our study estimates the relationship between adoption/non-

[8] We interchangeably use process capability index, process capabilities and process capability. Similarly, we also use practice capability index, practice capabilities and practice capability.

adoption of process and practice capabilities, and performance of firms in and outside clusters.

Measurement of Performance

Studies measure performance through growth rate, return on assets, net profits, growth in profits, etc. Although these measures are appropriate to capture performance, we could not measure most owing to the cross-sectional nature of research design. Further, a number of firms did not report/respond to the question on profits and returns. Scholars suggest that employee productivity can also be taken as a measure of performance (Grupp & Shlomo, 2001; Lichtenberg & Siegel, 1991; Tsai, 2004). Productivity as a measure of performance relates to profitability i.e., it measures the ability of the firm to lower costs and increase its competitiveness (Grupp & Shlomo, 2001; Lichtenberg & Siegel, 1991). Thus, we measured performance through productivity for this study. We operationalize employee productivity as sales divided by total number of employees.

Measurement of Locational Characteristics

We have already discussed that certain locational characteristics (i.e., presence of a firm in and outside clusters) may have contributed to performance of firms within and outside cluster. Some of these differences might have led to performance differentials between firms in and outside clusters.

1. *Perceived advantages of location*: Various scholars identified some of the advantages for firms to locate in clusters. These include proximity to customers, suppliers, consultants/service providers, competitors, better access to information on fairs/exhibitions, availability/access to skilled labour, raw material, other intermediate inputs and access to research & physical infrastructure (Krumme, 1969; Martin & Rogers, 1994; Hubert Schmitz & Nadvi, 1999; Simmie, Sennett, Wood, & Hart, 2002). Exhibit 10 shows some of the perceived advantages of locations. We asked firms in both clusters and outside clusters to rate the advantages of their location on a scale of 1 to 5 for the advantages identified in exhibit 10. Apart from advantages, we have also separated out the infrastructural and government policy support for firms in and outside clusters.
2. *Infrastructural and Government support*: As discussed earlier studies have already shown that firms locate in regions of best infrastructure. Infrastructure includes both physical infrastructure (Power, Telecom, Transportation, Entertainment, livability of the city, facilities within industrial estate, security) and intellectual infrastructure (Technology development centers, presence of technical institutions, basic educational facilities). Exhibit 10 shows some of the infrastructural services available across locations, which might contribute to performance differentials across cluster and non-cluster firms. Similarly we have also shown that specific government policies help firms in particular locations, thus contributing to their better performance. Exhibit 10 shows some of the indicators of government policy. As part of this study, we seek responses on whether firms face any specific problems / constraints due to infrastructure and government policy across cluster and non-cluster locations.

Data Analysis

As discussed earlier, this paper explores the relationship between capabilities and performance of firms between cluster and non-cluster locations. Firstly, we use an independent sample t-test to show if there exists significant differences in performance of firms in and outside clusters. Secondly, we use regression to estimate the relationship between capabilities, location dummy and performance. Location characteristics are captured using a location dummy (presence of a firm in and outside clusters) to identify if significant differences exist in performance between cluster and non-cluster locations. We estimate the above relationship after conducting outlier analysis and removing outliers before estimation (Hair, Anderson, Tatham, & Black, 1998). We test for homogeneity of the sample while estimating the above relationships (Gujarati, 1995). If the sample is not homogenous, we estimate the relationship between capabilities and performance separately for firms in and outside clusters. Since location dummy was found significant, we find significant differences in capabilities and locational characteristics. Firstly, we employ independent sample t-test for identifying significant differences in proportion of firms in and outside clusters adopting various processes and practices. Secondly, we use an independent sample t-test for identifying significant differences in means of various perceived advantages of location across cluster and non-cluster locations. Similar to the above, we tested for significant differences in proportion of firms facing constraints due to infrastructural services / government policy across cluster and non-cluster locations. The next section would present the analysis related to determinants of performance of IT firms.

Determinants of Performance – Analysis & Results

Out of a total sample of 243 IT firms, all the responses were useful. Some of the basic characteristics of the sample are given in table 1.

Table 1: Basic Characteristics of IT sample (for 2003)

Variable	Mean Age (in Years)	% Exports	Net profits (Rs. In Lakhs)	Capacity Utilization (%)
Cluster	8.23	56.63	1559.60	89.26
Non-Cluster	6.44	30.32	24.14	89.48

Table 1 shows that age of the firm, export percentage and net profit are consistently higher for cluster firms. This shows that the performance of firms in clusters is better than non-cluster locations for IT sector. A preliminary analysis of IT firms across cluster and non-cluster locations shows that performance of firms in clusters is significantly better. Table 2 provides comparison of performance of IT firms in and outside clusters. It shows means and standard deviations of employee productivity, sales and total number of employees for cluster and non-cluster firms separately. It also shows whether these means are significantly different. The average productivity for IT firms in clusters is Rs. 52.82 Lakhs, whereas it is Rs. 9.96 Lakhs for IT firms outside clusters (Table 2). Table 2 also shows that IT firms in clusters have significantly higher sales and higher number of employees per firm in comparison to firms outside clusters. Although the variance is higher for firms in clusters, our analysis after controlling for variance differentials still shows that performance of IT firms in clusters is significantly better[9].

Table 2: Performance of IT firms (both MNC owned and domestic) across cluster and non-cluster locations

IT firms	Cluster Firms			Non-cluster Firms			Means are Significantly different
	Mean	Standard deviation	No. of firms	Mean	Standard deviation	No. of firms	
Sales (Rs. In Lakhs)	8743.20	57220.15	159	532.73	1611.00	53	Y*
Employee Productivity	52.82	139.35	156	9.96	21.15	53	Y**
Total Number of Employees	138.12	295.79	179	48.6	155.44	60	Y**

**- p<0.05, *-P<0.1; Y- means are significantly different;

Overall, our analysis shows that IT firms in clusters perform better. The results / analysis discussed later would identify some of the key factors contributing to better performance of IT firms in clusters. We have already discussed in the last section that process capabilities is sum of application development processes in a firm. Of 243 firms, only 218 firms adopt processes relating to application development. Other firms were either adopting processes related to package implementation activities or developing products

[9] The tests for differences in means were conducted under the assumption that variances of cluster and non-cluster samples are not equal.

only. Due to the above, our sample of IT firms gets reduced to 218 (i.e., 113 firms providing both application development as well as package implementation services and 105 firms providing only application development).

Analysis of Performance

We estimate the relationship between process capabilities, practice capabilities, location dummy (presence/absence of a firm in a cluster) and performance. We also hypothesize that quality certification and skilled labour can also help IT firms in gaining process and practice capabilities. Since they can serve as good proxies for capabilities of IT firms, we also estimate the relationship between capabilities, skilled labour, quality certification, location dummy and performance.

Firstly, we estimate the relationship between process capabilities, practice capabilities, location (presence / absence of a firm in a cluster) and performance of IT firms. Similar to other studies, we controlled for size of the firm (Guthrie, 2001; Huselid, 1995; Konrad & Mangel, 2000). The following equation is estimated.

$$\ln Y = \alpha + \beta_1 \ln X1 + \beta_2 \ln X2 + \beta_3 X3 + \beta_4 \ln X4 \text{-----I}$$

where Y is employee productivity, X1 is process capability index, X2 is practice capability index, X3 is total number of employees and X4 is location dummy. We present the results for the same as model I (combined sample) in Table 3. Results in Table 3 show that ceteris paribus process and practice capabilities positively contribute to performance of IT firms for the combined sample. Tests did not reveal either multicollinearity or heteroscedasticity. However, we find that the combined sample (of cluster and non-cluster firms) is not homogenous (Gujarati, 1995). Thus, there exists significant differences between cluster and non-cluster firms and as such, they cannot be combined for analyzing the determinants of performance. These differences between firms might be due to differences in locational characteristics. Later, we capture some of the locational differences that might have contributed to performance differentials. Therefore, we estimate the above relationship separately for firms in and outside clusters

$$\ln Y = \alpha + \beta_1 \ln X1 + \beta_2 \ln X2 + \beta_3 \ln X3 \text{-----II}$$

Where Y is employee productivity, X1 is process capability index, X2 is practice capability index and X3 is total number of employees of a firm. We present the results of the same as model II in Table 3.

Table 3: Performance Determinants of IT firms – Process Capabilities, Practice Capabilities and Location

Variable	Combined sample	Cluster	Non-cluster
	Model I	Model II	Model II
Constant	-0.334 (0.674)	-1.664 (0.105)	0.237 (0.789)
Ln (Process Capabilities)	0.700 (0.051)*	0.971 (0.028)**	-0.334 (0.493)
Ln (Practice Capabilities)	0.452 (0.039)**	0.905 (0.005)***	0.314 (0.264)
Location	-1.281 (0.000)***	-	-
Ln (Total number of employees)	0.066 (0.470)	-0.060 (0.556)	0.324 (0.030)**
F-Statistic	15.43 (0.000)***	7.68 (0.000)***	2.25 (0.096)*
R^2	0.264	0.159	0.1355
Adjusted R^2	0.246	0.139	0.0752
Chow (Test for homogeneity)	2.32 (0.045)**	-	-

***, **, and * indicate significance at 1, 5 and 10 percent levels respectively

Table 3 shows that process and practice capabilities contributes positively to IT firm performance in clusters. Results in Table 3 show that process and practice capabilities are not significant for IT firms outside clusters. Presumably, cluster location facilitates leveraging of adopted processes and practices to firms' advantage. Cluster firms may also be using them more intensely than non-cluster firms may. High intensity of use of processes and practices combined with higher efficacy due to "inputs" available in a cluster results in better performance of cluster firms. Besides, it can be seen from Table 3 that size of the firm contributes to the performance of IT firms only outside clusters. It was argued earlier that that Indian IT industry was principally driven by availability of cheap and skilled labour (i.e., low cost of employees) rather than capabilities (Heeks, 1996). However, recent studies suggest that Indian IT industry is developing significant capabilities (Athreye, 2002). The above results (Table 3) suggest that i.e., process and practice capabilities significantly affect performance of IT firms in clusters. Only size has a positive influence on the performance of IT firms outside clusters. Thus, firms outside clusters are driven more by economies of scale rather than by capabilities. With capabilities becoming major determinants of firm productivity in cluster locations, economies of scale do not seem to play an important role.

Apart from capabilities, studies show that availability and access to skilled labour is a significant advantage for IT firms in clusters (Glaeser, Kallal, Scheinkman, & Shleifer, 1992). Some of the knowledge of processes and practices may actually reside in skilled labour too. Moreover, skilled workers may be able to use “adopted” proceses and practices in a more efficient manner. Since, we may not have measured process and practice capabilities completely, we contend that skilled labour can serve as a good proxy for process and practice capabilities. Quality certifications help firms in reducing defect rates, cycle times, etc. Thus, firm having quality certification may have developed certain practice capabilities. Consequently, quality certification can also be an important determinant of performance for IT firms. As discussed earlier, we estimate the relationship between process capabilities, practice capabilities, skills of employees, presence / absence of quality certification, location dummy (i.e., presence / absence of a firm in a cluster) and performance of firms. We measure skilled labour as proportion of engineers in each firm.

$$\ln Y = \alpha + \beta_1 \ln X1 + \beta_2 \ln X2 + \beta_3 \ln X3 + \beta_4 X4 + \beta_5 X5 + \beta_6 X6 --- III$$

where Y is employee productivity, X1 is process capability index, X2 is practice capability index, X3 is proportion of engineers in a firm, X4 is quality certification (take a value 1 if the firm is certified otherwise it takes a value zero), X5 is the total number of employees and X6 is the location dummy (presence/absence of a firm in a cluster). The results of the same is presented as model III in Table 4. Results in Table 4 show that the combined sample of IT firms is not homogeneous. Thus, we estimate the relationship separately for IT firms in and outside clusters.

$$\ln Y = \alpha + \beta_1 \ln X1 + \beta_2 \ln X2 + \beta_3 \ln X3 + \beta_4 X4 + \beta_5 \ln X5 --- IV$$

where Y is employee productivity, X1 is process capability index, X2 is practice capability index, X3 is proportion of engineers in a firm, X4 is quality certification (take a value 1 if the firm is certified otherwise it takes a value zero), and X5 is total number of employees. The results for model IV are given in Table 4.

We observe that process capabilities remain a significant positive determinant of IT firm performance in clusters, whereas practice capabilities turn insignificant. We also find that only skilled labour availability (proportion of engineers) is significant for IT firms in clusters. Practice related capability for IT firms might have been partially captured by skilled labour in IT firms. Since practices are more tacit in nature than product/process knowledge, one can argue that these get captured more if firms possess a skilled work force.

Table 4: Performance Determinants of IT firms – Capabilities, Skills, Quality certification and Location

Variable	Combined Sample	Cluster	Non-cluster
	Model III	**Model IV**	**Model IV**
Constant	0.637 (0.346)	-1.170 (0.216)	1.637 (0.041)**
Ln (Process Capabilities)	0.472 (0.094)*	0.932 (0.019)**	-0.896 (0.039)**
Ln (Practice Capabilities)	0.237 (0.192)	0.275 (0.333)	0.435 (0.071)*
Ln (Percentage of engineers)	0.081 (0.411)	0.358 (0.002)***	0.023 (0.815)
Quality dummy	0.002 (0.990)	-0.297 (0.215)	1.321 (0.004)***
Location dummy	-1.421 (0.000)***	-	-
Ln (Total number of employees)	0.023 (0.794)	-0.058 (0.596)	0.026 (0.851)
F-Statistic	12.33 (0.000)***	6.940 (0.000)***	3.40 (0.011)**
R^2	0.3071	0.1730	0.2981
Adjusted R^2	0.2822	0.1391	0.2104
Chow (Test for homogeneity)	3.10 (0.004)***	-	-

***, **, and * indicate significance at 1, 5 and 10 percent levels respectively

Surprisingly, we find that process capabilities negatively contribute to performance of firms outside clusters (Table 4). One of the probable reasons for the above sign is that processes might have been adopted recently and it may take time before these contribute to performance. Secondly, despite investing in process capabilities, firms may not have realized benefits because of the absence of complementary inputs/services. Thus, firms may not be deriving agglomeration benefits in non-cluster locations. Investments in process capabilities (in the absence of other inputs that are not available in non-cluster locations) alone may be detrimental to performance. Presence of a quality certification positively contributes to performance of firms outside clusters. One of the reasons could be that this certification may serve as a branding initiative and thus it might serve as a signalling mechanism. This signalling mechanism besides improving sales may have probably helped IT firms outside clusters in improving its performance through greater access to various networks for these firms over time (Arora & Asundi, 1999). Besides, as mentioned earlier, it is possible that while cluster firms utilize the adopted processes and practices more extensively within a firm, while non-cluster firms may not be doing so. Consequently, quality certification may be a better measure for capturing capabilities for such firms.

Thus, we find that process capabilities, practice capabilities and the presence of a firm in clusters contributes to better performance of IT firms in clusters. In the later part of this section, we find the factors explaining the differences in capabilities and locational characteristics that contributed to better performance of IT firms in clusters. The analysis of these differences might give us more insights into how capabilities and locational features provide advantages to cluster firms.

Capability Differentials between IT Firms in and outside clusters

Studies have indicated that firms adopting high-end processes derive greater value i.e., firms following processes such as requirement analysis, high-end design, low-end design, etc (Joseph & Abraham, 2005; Schware, 1987). We computed the proportion of firms in and outside clusters adopting each of the processes. The percentage of firms adopting various processes is given in Table 5. It also shows if the adoption of a process is significantly different for firms in clusters and outside clusters. This is tested through an independent sample t-test for proportions. Analysis (Table 5) shows that a higher percentage of IT firms in clusters adopt requirement analysis, high level design, low level design, system requirement specification and functional requirement specification (high-end processes for application development) in comparison to firms outside clusters. Table 5 shows that a significantly higher proportion of IT firms in clusters adopt high-level design, low-level design and functional requirement specification in comparison to firms outside clusters. Some of the recent studies have already shown that requirement analysis, high-end design, low-end design add greater value and thus we can term them as higher end of the software development cycle. Consequently, other activities of software development life cycle like coding, testing, installation can be termed as low-end activities. From table 5 and the above discussion, we can infer that IT firms outside clusters are involved in activities relating to lower end of software development life cycle, whereas IT firms in clusters undertake activities at the higher end of the software development life cycle. This may partly explain the non-significance of process capabilities for IT firms outside clusters.

Table 5: Percentage adoption of various processes by IT firms within and outside clusters

Processes	Cluster Firms	Non-cluster Firms	Test for difference in Proportions
Application Development			
Requirement Analysis	90	88	N (C)
High Level Design	90	72	Y (C)*
Low Level Design	83	67	Y(C)
System Requirement Specification	87	83	N(C)
Functional Requirement Specification	90	73	Y(C)
Coding	95	92	N(C)
Testing	95	92	N(C)
Installation	91	93	N(NC)
Post Production Support	87	90	N(NC)

*-p<0.05; Y- proportions are significantly different; N- proportions are not significantly different; NC-Non-cluster firms have higher proportion; C-Cluster firms have higher proportion.

Further, we compute proportion of firms in and outside clusters adopting each of the practices. An analysis of practices adopted by IT firms' shows that they are on an average higher for firms in clusters (Table 6). Table 6 also shows whether the proportion of firms adopting various practices is significantly different for firms in and outside clusters. While a higher proportion of firms adopt practices; code readability, code reusability, benchmarking, informal knowledge management, physical security, system downtime, mentoring and cross-functional teams are significantly higher for firms in clusters.

Table 6: Percentage of various practices adopted by IT firms in and outside clusters

Practices Adopted	Cluster Firms	Non-cluster Firms	Test for difference in Proportions
Coding Practices			
Code Readability	84	60	Y (C)*

Code Reusability	87	65	Y(C)
Error Reduction	85	77	N(C)
Speed of coding	62	62	N
Code Execution	78	68	N(C)
KM Practices			
Testing	91	83	N(C)
Benchmarking	66	48	Y(C)
Formal Knowledge Management	56	45	N(C)
Acquiring new tools	84	85	N(C)
Informal KM practices	61	23	Y(C)
Security Practices			
Hardware maintenance	67	57	N(C)
Data Security	83	73	N(C)
Disaster Management	71	57	N(C)
Physical Security	74	52	Y(C)
System downtime	72	50	Y(C)
HR Practices			
Training Practices	84	83	N(C)
Job rotation	69	60	N(C)
Mentoring	71	43	Y(C)
Cross functional teams	73	43	Y(C)

*-p<0.05; Y- proportions are significantly different; N- proportions are not significantly different; NC-Non-cluster firms have higher proportion; C-Cluster firms have higher proportion.

Differences in locational characteristics for IT firms within and outside cluster.

Apart from capabilities, we have found that presence of a firm in clusters (due to various perceived advantages including infrastructure and government support) contribute towards better performance of firms in clusters. The analysis given below identifies some of the differences in perceived advantages by firms, infrastructural bottlenecks and government constraints for firms within and outside clusters. These can be some of the reasons contributing towards better performance of firms in clusters.

Differences in perceived advantages of location

As discussed earlier, we compute means of the variables (advantages identified for this study) for cluster and non-cluster firms separately. Further, we compare mean differences in the perceived advantages[10] of firms located in a cluster vis-à-vis outside clusters through an independent sample t-test. Table 7 shows that means of the perceived advantages of location for cluster and non-cluster locations separately. It also shows if significant differences exists in means across cluster and non-cluster locations. Except for

[10] It is important to note that the response on advantages of a location is based on perception of the firms on a scale of 1 to 5.

proximity to customers, information from competitors and better infrastructure, Table 7 shows significant perceived differences in advantages for IT firms locating in clusters[11].

Table 7: Comparison of locational advantages for IT firms in clusters vis-à-vis outside clusters

Advantages of locating in a cluster (IT industry)	Type	No. of firms	Mean	Significance
Proximity to customers	Cluster	176	2.94	N
	Non-cluster	59	3.12	
Information from competitors	Cluster	173	2.91	N
	Non-cluster	59	2.61	
Information about competitors	Cluster	172	3.03	Y*
	Non-cluster	59	2.63	
Availability of skilled labour from competitors	Cluster	175	3.15	Y*
	Non-cluster	58	2.64	
Access to skilled labour	Cluster	180	3.92	Y
	Non-cluster	59	3.12	
Presence of hardware & software suppliers	Cluster	180	3.76	Y
	Non-cluster	59	3.17	
Better access to support services	Cluster	177	3.67	Y
	Non-cluster	57	3.05	
Better access to training facilities	Cluster	177	3.63	Y
	Non-cluster	57	3.05	
Better access to R&D Institutions	Cluster	165	3.25	Y
	Non-cluster	57	2.61	
Better access to information on fairs & exhibitions	Cluster	174	3.57	Y
	Non-cluster	59	2.69	
Availability of maintenance / repair services	Cluster	179	3.79	Y
	Non-cluster	59	3.39	
Availability of better infrastructure	Cluster	181	3.55	N
	Non-cluster	59	3.64	

*-5% level of significance; others are significant at 1% level; Y- means are significantly different; N- means are not significantly different

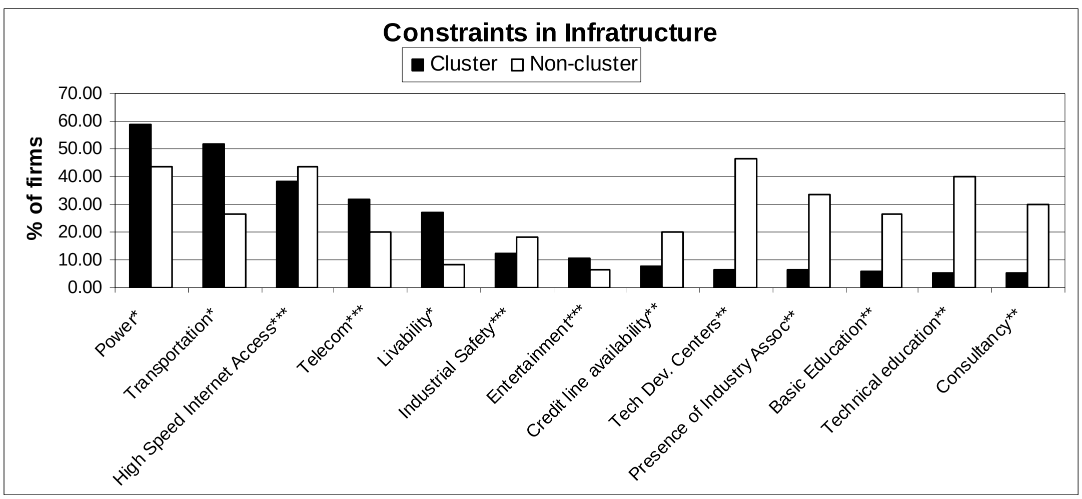
From Table 7, we can observe that IT firms in clusters derive significant advantages due to access to skilled labour (including from competitors), presence of hardware & software suppliers, better access to support services, training facilties, R&D institutions and availability of maintenance/repair services (Krumme, 1969; Marshall, 1890; H. Schmitz,

[11] The Appendix 5 shows the t values of the independent samples test for both IT and electronics.

1995). Thus, we can deduce that IT firms derive resource-based advantages (especially proximity of suppliers, availability of maintenance/repair services, skilled labour, training facilities and R&D institutions) in clusters and this may be one of the factors explaining performance differentials. Estimates reported in Table 7 show that differences in advantages due to availability of infrastructure are insignificant. A further dis-aggregation of various infrastructural services shows a different picture (given below).

Differences in infrastructure and government policy constraints

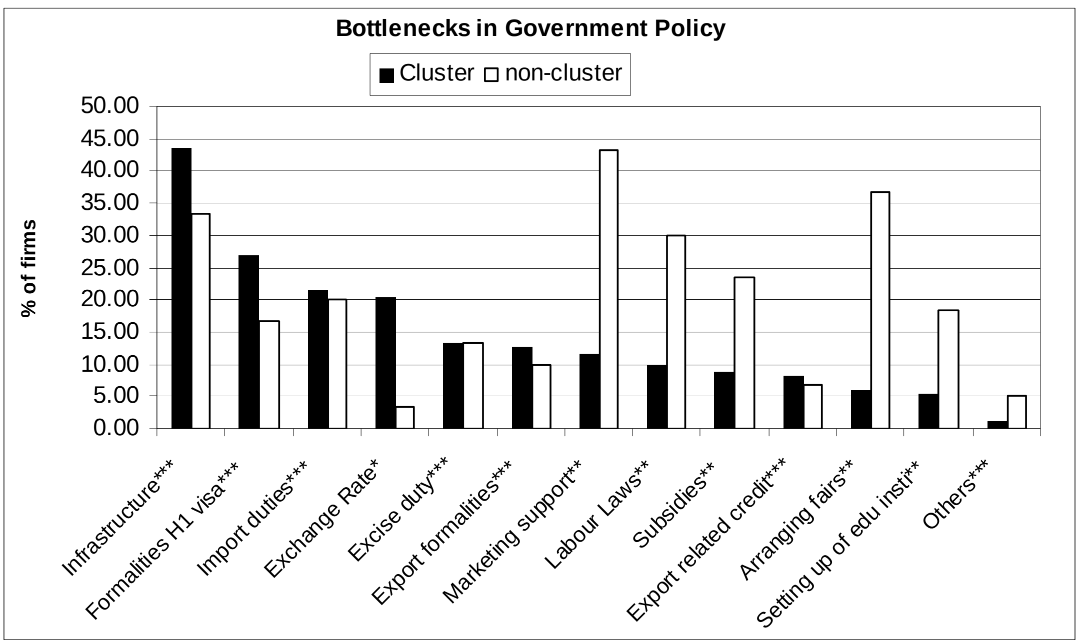
Martin & Rogers (1994) find that firms locate in regions with best infrastructure. Cooke et al., (1997) suggest that provision of research infrastructure, specialized training systems, policies for physical infrastructure play a critical role in regional innovation. Figure 1 shows proportion of IT firms facing constraints in various kinds of infrastructure across cluster and non-cluster locations. Additionally, we compute significant differences in proportion of firms in and outside clusters facing various constraints. Figure 1 also shows that there are significant differences on some infrastructural services across cluster and non-cluster locations.



*-Significantly higher proportion of cluster firms face problems
**-Significantly higher proportion of firms outside clusters face problems
***-Firms in clusters and outside clusters are not significantly different from each other

Figure 1: Constraints in Infrastructure faced by IT firms in clusters and outside clusters

From Figure 1, we observe that a high percentage of IT firms in both cluster and non-cluster locations face problems due to lack of physical infrastructure like power, transportation, high-speed internet access, and telecom. We can observe that a significant proportion of IT firms in clusters face problems due to physical infrastructure (e.g., power, transportation and livability) in comparison to IT firms outside clusters. Further, significantly higher proportion of IT firms outside clusters face problems due to absence of technology development centers, industry associations, basic education facilities, technical education facilities and consultancy/support services. From these results, one can argue that while IT firms in both clusters and outside clusters face problems due to physical infrastructure i.e., power, high-speed internet access, transportation and telecom, only IT firms outside clusters face constraints due to intellectual infrastructure (e.g., technology development centers, presence of industry associations, technical education facilities, etc). These differences in infrastructure can lead to differences in both capabilities of firms and thus performance differentials of firms. For example, presence of technology development centers, technical education institutions may help in capabilities of IT firms, whereas presence of industry associations, consultancy / support services can contribute to both capabilities and performance of IT firms.



*-Significantly higher proportion of cluster firms face problems
**-Significantly higher proportion of firms outside clusters face problems
***-Firms in clusters and outside clusters are not significantly different from each other

Figure 2: Constraints due to Government policy faced by IT firms in and outside clusters

While there is a constraint with respect to certain kinds of infrastructure in non-cluster locations, analysis of government policies show that firms outside clusters face problems due to marketing support, labour laws, subsidies, arranging fairs and educational institutions (Figure 2). As explained above, similar analysis was also conducted to identify significant differences in constraints due to government policies for firms in and outside clusters. One of the plausible explanations for IT firms outside clusters seeking marketing support is that they are currently dependent on local/domestic market in comparison to IT firms in clusters. IT firms outside clusters also indicate constraints due to labour laws. This is probably because of a problem in retaining good skilled labour force.

Thus, some of the differentials like proximity to service providers, availability of maintenance/repair services, presence of industry associations, presence of hardware and software suppliers, easier access to national and international market through availability of information on fairs and exhibitions could have lead to better performance of firms in clusters. Some of the other differentials like access to R&D institutions, training facilities, presence of technical educational facilities in clusters could have lead to greater local knowledge flows /learning and capability formation for firms in clusters too which in turn leads to better performance of firms.

Summary of Findings

Firstly, we show that process and practice capabilities significantly contribute to performance of firms in clusters. They do not contribute towards performance of firms outside clusters. Our results show that characteristics of firms are significantly different between firms within and outside clusters. These could be due to differences in locational characteristics across cluster and non-cluster locations. Size of the firm is also a significant determinant of performance of firms outside clusters. Interestingly, economies of scale are not relevant in explaining productivity differentials in clusters. Thus, while economies of scale matter for firms outside clusters, capabilities contribute towards performance of firms within clusters. Which of these locational characteristics contribute to differences in performance of firms? We find that there are significant differences in perceived advantages of firms, infrastructure and government support for firms in clusters vis-à-vis non-cluster locations. Typically, cluster firms are better placed in terms of availability of hardware and software suppliers, skilled labour, information about competitors, availability of training facilities, access to R&D institutions, availability of maintenance/repair services and information on fairs & exhibitions. Additionally, the cluster firms do not face problems in intellectual infrastructure like technology development centers, basic and technical educational facilities and consultancy services. These might have contributed to performance differentials between firms within and outside clusters.

Studies over the last decade highlight knowledge flows and learning as a key input for agglomeration of firms (Acs, Audretsch, & Feldman, 1994; Audretsch & Feldman, 1996; Feldman, 1999). Although case studies highlight some of the determinants of these knowledge flows and learning by firms in clusters, there have not been many empirical studies analyzing determinants of performance (Bell & Albu, 1999; Saxenian, 1990; Hubert Schmitz & Nadvi, 1999) of firms in clusters and outside clusters. Our study investigated the determinants of firm performance in industrial clusters vis-à-vis outside clusters.

To an extent, we can generalize our results as follows:

a) Capabilities and locational characteristics together help in better performance of firms in clusters.
b) Scale economies matter for performance of firms outside clusters.

Implications

Over the recent years, there has been an intense debate on clustering. The debate was to seek explanations to the industrial clustering phenomenon. Even today, the significance cannot be undermined, since clusters continue to dominate the industrial scenario worldwide. Policy makers and academicians are struggling to find answers to the phenomenon of clustering. They are also trying to address questions like if government can kick start clustering process. Thus, most of the debate centers on finding significant factors affecting performance of firms in clusters. Most studies before 1990 explained clustering through cost/resource based advantages derived through co-location of firms (Krumme, 1969). But the recent perspectives propounded by scholars from various streams emphasize knowledge based explanations (Feldman, 1999; Saxenian, 1990; Hubert Schmitz & Nadvi, 1999). Infact, most studies in developed countries context argue that industrial clustering is primarily due to knowledge based advantages. In tune with developments in developed countries, recent studies in developing countries also focus on knowledge based explanations (Hubert Schmitz & Nadvi, 1999). However, most studies highlight knowledge based explanations through case studies. Interestingly, recent studies in developing countries also ignore the resource / cost based explanations. Our study makes a departure from the current stream and brings back the cost/resource based explanations into focus along with knowledge based explanations. Firstly, we show that capabilities affect performance of firms in clusters using large sample data. We also show that apart from capabilities, locational characteristics too contribute towards better performance of firms in clusters. Some of these differences in locational characteristics that contribute to performance might include availability of raw material, skilled labour, maintenance/repair services, training facilities, R&D institutions, technology development centers, etc. Thus, we highlight that both cost and knowledge based explanations matter for better performance of firms in clusters.

Thus, this paper extends the debate in seeking explanations for industrial clustering in the following manner. Both capabilities and resources availability continue to be an explanation for performance differentials across cluster and non-cluster locations. Our study is the first of its kind to analyze the determinants of performance of firms in clusters i.e., estimates the relationship between capabilities, performance and location of firms using large sample data. Additionally, we developed new measures for capabilities at the firm level. Besides, our study is one of the few studies which draw comparisons of firms in and outside clusters.

One of the principal implications for policy makers is that governments cannot start clusters only by providing either access to resources (for example, raw materials, maintenance / repair services, etc.) or knowledge based resources (like availability of skilled labour, R&D labs, training institutions, consultants, etc). Thus, both the resources as well as the ability of the firms to use these resources matter for better performance of firms in clusters. Since governments may not be able to provide all the necessary advantages as discussed above or it cannot help firms develop the ability to use these resources, investing in new clusters should not be a priority for governments. It should rather provide an enabling environment for firms in existing clusters. Since we find that firms in and outside clusters do not face significantly different constraints due to physical infrastructure, government should strive to reduce the infrastructural costs in high technology clusters. This would help firms reduce costs as well as help them in building better capabilities and thus better performance. Besides, if governments are interested in providing support for firms outside clusters, it needs to invest in intellectual infrastructure (e.g., technology development centers, consultancy services, technical education institutions, industry associations) and provide marketing support.

Further, since firms in clusters outperform non-cluster firms and one of the principal explanations for the above is that clusters possess both knowledge as well as resource based advantages. Thus, managers making location decisions should be wary of locating outside clusters, since they would not be able to derive agglomeration advantages (knowledge as well as resources) in comparison to firms located in clusters. While managers of firms in clusters perform better due to their investments in capabilities, managers for firms outside clusters need to invest in quality certification. Quality certification may be the only means to build up both brand image as well as certain capabilities for firms outside clusters.

Exhibit 1: Growth of IT industry (1994-2004)

Year	Export Revenues	Export Growth (%)	Domestic Revenues	Domestic Growth (%)
1994/95	480	53.15	350	N.A.*
1995/96	734	52.63	490	40.00
1996/97	1085	47.82	670	36.73
1997/98	1750	61.29	1152	71.94
1998/99	2650	51.42	1380	19.79
1999/2000	4000	50.94	1537	11.37
2000/01	6300	57.50	2024	31.68
2001/02	7647	21.38	2265	11.90
2002/03	9545	24.82	2769	22.25
2003/04	12200	27.81	3374	21.84

* - figures are not available. Source: Nasscom (2003) & Nasscom (2004), Arora, et.al, (2001), Heeks (1996)

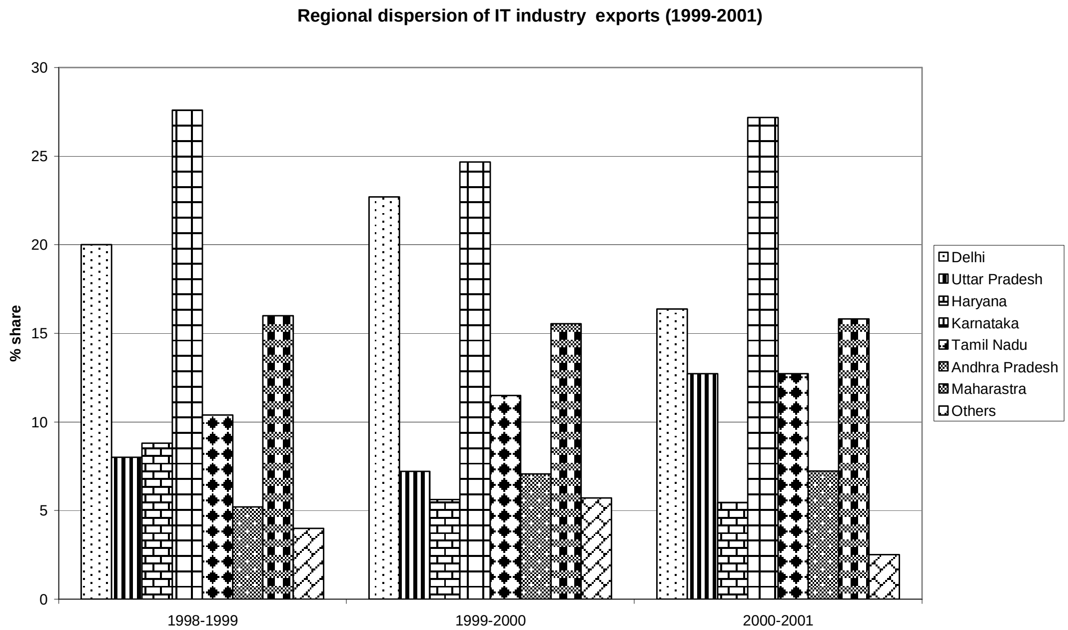
Exhibit 2: Revenue contribution and growth in export demand for IT services

Growth in Export Demand for IT services - FY

SERVICE LINE	INDIA		
USD Billion	FY'03	FY'04	Growth
Project-Oriented Services	**3.23**	**3.85**	**19.2%**
IT Consulting	0.08	0.12	50.0%
System Integration	0.10	0.14	40.0%
Custom Application development and maintenance	3.02	3.54	17.2%
Network consulting and integration	0.03	0.05	66.7%
IT Outsourcing	**1.94**	**2.45**	**26.6%**
IS Outsourcing	0.01	0.02	100.0%
Application Outsourcing	1.85	2.16	16.8%
Network Infrastructure Management	0.08	0.27	260.0%
Support and Training	**0.37**	**0.61**	**64.9%**
IT Training and Education	-	0.02	-
Hardware Support and Installation	0.02	0.04	100.0%
Packaged Software support and installation	0.35	0.55	57.1%
TOTAL	**5.54**	**6.91**	**24.8%**

Source: NASSCOM, IDC

Exhibit 3: State wise exports of computer software and services (1998-99 to 2000-2001)



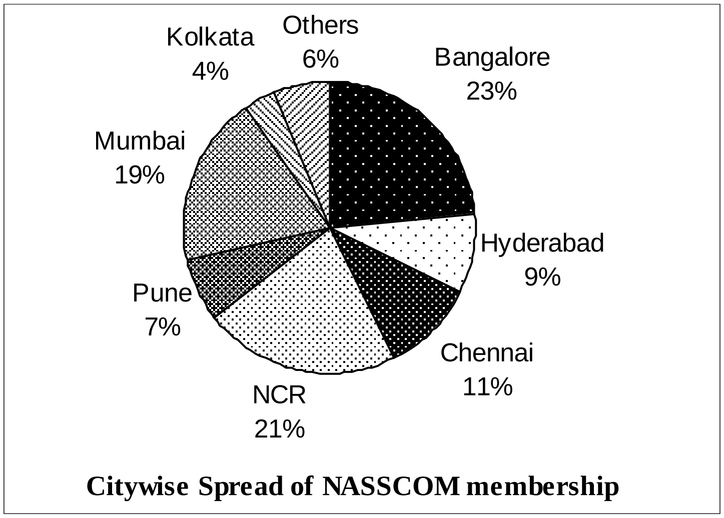
Source: Indiastat

Exhibit 4: Skilled labour availability in IT and Electronics (Source: Indiastat)

State wise institutions Offering Courses in Information Technology/Electronics (Degree Level) (2000-01)						
	Information Technology		Computer Science and Engineering		Electronics and Communication Engineering	
States/UTs	Institutions	Intake	Institutions	Intake	Institutions	Intake
Andhra Pradesh	74	4230	101	7020	96	6445
Andaman & Nicobar Islands	0	0	0	0	0	0
Arunachal Pradesh	0	0	1	30	0	0
Assam	0	0	2	60	0	0
Bihar	6	225	9	385	9	425
Chandigarh	1	30	1	30	0	0
Daman & Diu	0	0	0	0	0	0
Delhi	3	165	2	120	7	425
Goa	0	0	2	120	2	120
Gujarat	16	1010	18	1140	18	1040
Haryana	14	710	18	1310	22	1550
Himachal Pradesh	0	0	2	90	2	105
Jammu & Kashmir	1	60	3	140	4	210
Karnataka	55	2795	80	5820	66	5570
Kerala	12	620	20	1173	25	1575
Madhya Pradesh	26	1330	32	2110	17	1015
Maharashtra	85	4710	106	7410	126	8603
Manipur	0	0	1	60	1	60
Meghalaya	1	60	1	60	1	60
Mizoram	0	0	1	40	1	40
Nagaland	0	0	0	0	0	0
Orissa	14	785	25	1525	19	1055
Pondicherry	3	160	5	280	4	200
Punjab	8	410	11	540	10	550
Rajasthan	10	420	19	1124	13	822
Sikkim	1	60	1	90	1	90
Tamil Nadu	115	7379	150	10153	148	9731
Tripura	0	0	1	40	0	0
Uttar Pradesh	38	2025	62	3858	44	2685
West Bengal	26	1320	26	1460	18	1040
India	509	28504	700	46188	654	43416

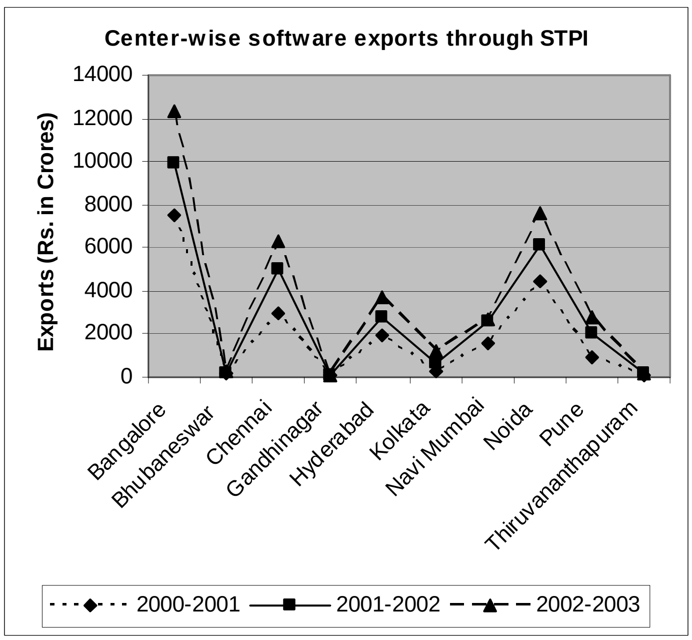
State wise institutions Offering Courses in Information Technology/Electronics (Diploma Level) (2000-01)						
	Information Technology		**Computer Science and Engineering**		**Electronics and Communication Engineering**	
States/UTs	**Institutions**	**Intake**	**Institutions**	**Intake**	**Institutions**	**Intake**
Andhra Pradesh	0	0	52	2585	54	2890
Andaman & Nicobar Islands	0	0	1	10	0	0
Assam	1	30	2	50	2	50
Bihar	16	540	13	450	9	365
Chandigarh	0	0	0	0	2	70
Delhi	0	0	10	490	9	405
Goa	0	0	1	30	2	70
Gujarat	15	800	20	1003	15	783
Haryana	5	220	22	950	17	790
Himachal Pradesh	1	30	5	135	5	150
Jammu & Kashmir	2	90	12	530	9	400
Karnataka	26	1140	141	6869	153	6935
Kerala	0	0	31	1290	11	450
Madhya Pradesh	14	535	14	565	2	100
Maharashtra	50	1980	88	5015	76	4010
Manipur	0	0	0	0	1	30
Meghalaya	0	0	1	20	1	30
Mizoram	0	0	1	30	1	30
Orissa	7	270	12	495	3	95
Pondicherry	0	0	2	66	3	103
Punjab	6	220	22	1070	25	1140
Rajasthan	1	30	7	290	0	0
Sikkim	0	0	1	30	0	0
Tamil Nadu	6	310	27	1420	128	6960
Tripura	0	0	0	0	1	20
Uttar Pradesh	1	30	14	400	64	2127
West Bengal	1	30	10	370	14	400
India	152	6255	509	24163	607	28403

Exhibit 5: City wise distribution of IT firms in India



(Source: NASSCOM)

Exhibit 6: Center wise exports of IT firms located in STPI



(Source: Indiastat)

Exhibit 7: Distribution of IT Firms by Sales in and outside Clusters

Information Technology (Rs. in Million)	Actual distribution		Distribution of firms in clusters		Distribution of firms outside clusters		Predicted distribution	
	No.	%	No.	%	No.	%	No.	%
Blank	31	14	24	13	7	12	32	13
< 1	16	7	8	4	13	22	18	7
1-10.	45	19	23	13	24	40	31	13
10 - 20.	12	5	6	3	6	10	20	8
20 – 50	21	9	15	8	2	3	31	13
50 – 100	27	11	26	14	3	5	33	14
100 – 500	56	23	49	27	4	7	43	18
500 - 2500	27	11	18	10	1	2	22	9
> 2500	8	3	14	8	0	0	12	5
Total	243	100	183	100	60	100	243	100

Exhibit 8: Process Capability Indicators for IT firms

Processes for IT firms	
Application Development Processes	
Requirement Analysis	Y/N
High Level Design	Y/N
Low Level Design	Y/N
System Requirement Specification	Y/N
Functional Requirement Specification	Y/N
Coding	Y/N
Testing	Y/N
Installation	Y/N
Post Production Support	Y/N
Package Implementation Processes	
Solution Definition	Y/N
Solution Engineering	Y/N
Solution Development & Testing	Y/N
Solution Deployment & Roll out	Y/N
Solution Support	Y/N

Exhibit 9: Practices for IT firms

Coding Practices	
Code Readability	Y/N
Code Reusability	Y/N
Error reduction	Y/N
Speed of coding	Y/N
Code Execution	Y/N
KM Practices	
Testing	Y/N
Bench Marking	Y/N
Formal KM Sytems	Y/N
Acquiring New tools	Y/N
Informal KM Practices	Y/N
Security Practices	
Hardware Maintenance Practices	Y/N
Data Security	Y/N
Disaster Management	Y/N
Physical Security	Y/N
System downtime	Y/N
HR Practices	
Training practices	Y/N
Job rotation	Y/N
Mentoring	Y/N
Cross functional teams	Y/N

Exhibit 10: Locational Characteristics

Perceived advantages of a location	Infrastructural Services	Government Policy Constraints
Proximity to customers	Availability of Power	Import duties on hardware and software
Better access to information from competitors	Telecom services and communication facilities	Excise duty on software
Better access to information about competitors	Transportation facilities	Export related credit
Availability of skilled labour from competitors	Industrial safety and security	Physical infrastructure in the city
Access to skilled labour	Centers for better technical education	Export formalities
Presence of hardware and software suppliers	Basic educational facilities	Marketing support
Better access to support services	Consultancy and support services	Arranging fairs and exhibitions
Better access to training facilities	Credit line availability	Setting up of educational institutions (engg colleges)
Better access to R&D institutions	Technology development centers	Labour laws for the IT sector
Better access to information on fairs and exhibitions	Presence of Industry Associations	Formalities relating to the H1 visa
Availability of maintenance / repair services	High Speed Internet Access	Exchange rate
Availability of better infrastructure	Livability of the city	Subsidies
	Entertainment Services	

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